The Path to a Leak-Free Hydraulic System

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Leaks in hydraulic systems are expensive and potentially hazardous. But like any leak, they can be mended or prevented. Unlike traditional pipe leaks, however, they can lead to system contamination and shutdown if they are not handled with precision – and the right materials.

Either way, leaks in hydraulic systems are unacceptable and must be eliminated. More than 100 million gallons of hydraulic fluids are lost each year to preventable leaks, requiring 5.5 million man-hours to repair. The first step in eliminating them is to identify potential causes.

Hydraulic leak paths

In general, most leaks can be traced to a fault in design, assembly, operation, or repair. In an ideal pipe fitting, the connection of threads forms an impenetrable barrier against water. In reality, complete metal-to-metal contact is not achieved and the spaces left become leak paths. Commonly, leak paths are spiral-shaped because they follow the clearance between the crest and the root of pipe threads.

Unless major trauma occurs, virtually every leak in a hydraulic system is located at pipe joints and connections. For this reason, designers try to keep the number of joints in a hydraulic system to a minimum. A number of joints are necessary, however, for disassembly purposes in case of repair. Unfortunately, these essential joints often are assigned improper pipe support and sealing methods, leading to eventual joint failure.

The most unavoidable cause of leaks is human error. Because tapered hydraulic pipe threads are imprecise and cannot be installed with specific torque, it is up to the assembler to tighten joins accurately. Too much torque can crack or distort fittings, while too little results in improper alignment of thread flanks. In either case, leakage may not be evident immediately and could degenerate into a larger leak or a total line break. The risk of damage from improper assembly is multiplied each time routine maintenance requires disassembly and reassembly of the same joint.

Assuming hydraulic joints have been assembled correctly and no leak paths have been created, conditions from everyday operation can quickly lead to leaks. Excessive pressure in hydraulic lines will enlarge microscopic leak paths; vibration and shock can loosen joints; and different temperatures in the two components of a pipe joint (thermal cycling) can cause misalignment or cracking.

Hydraulic leak prevention

Reducing the number of fittings in a hydraulic system or using flared tubing will help prevent leaks. Unfortunately, these options are not usually viable to maintenance technicians.

Proactive steps can be taken, though. One is to gain a full understanding of how hydraulic fittings work. This will help in diagnosing problems as they occur and prevent future ones. Another more important step is to ensure a proper seal. The main objective of any thread sealant is to fill and plug potential leak paths. A proper thread sealant can counteract all but the most severe causes of hydraulic fitting leaks.

Anaerobic thread sealers

Appropriate anaerobic resin compounds can fill and cure in any existing leak path, as well as lock the joint to make it strong and leak-free. They are very forgiving of tolerances, tool marks, and even slight misalignment.

Anaerobic resin compounds offer a number of benefits for hydraulic or pneumatic fittings that exceed those of any other options currently available.

- Anaerobic thread sealants cure in the absence of air and remain liquid until the fitting is assembled. There is no evaporation and no hardening prior to assembly.
- Due to its high wicking ability, the product fills threads so well that nicks, scratches, and other imperfections in the fitting or housing will not cause leakage.
- The very slow cure speed of the adhesive allows adjustments to fittings during system assembly without breaking the seal in the threads.
- Once cured, anaerobic sealants lock fittings, preventing loosening due to vibration.
- Fittings originally sealed with most thread sealers can be re-used and re-treated with the same adhesive without the danger of leakage.
- All characteristics of anaerobic thread sealants are predictable so they can be selected for a specified cure time, shear strength, viscosity, chemical resistance, and gap-filling ability.
- Anaerobic sealants can withstand chemical attack from hydraulic fluids, solvents, fuels, lubricants, gases, and synthetics.
- Because they cure to form structural solids, anaerobic sealants are able to resist pressures beyond burst ratings of pipes.
- Each anaerobic thread sealant is different, but many can resist temperatures as low as -65° F and as high as 300° F.
- Unlike the tape and hard-setting sealants replaced by anaerobic materials, machinery adhesives will not contaminate lines and valves in hydraulic and pneumatic systems.

The combination of other sealing methods can increase effectiveness even more. An anaerobic thread sealant can make tapered fittings as effective as O-rings, but at a fraction of the cost. It also can improve the 98 percent effectiveness of yielding metal joints to 100 percent.

Proactively sealing hydraulic pipe joints is imperative to consistent equipment operation. Anaerobic adhesives are the most effective method of accomplishing this important task.

Sealing Methods

Method	Limitations
Anaerobic thread sealing adhesives - The right anaerobic resin compound can fill and cure in any existing leak paths, as well as lock the joint together to make it strong and leak free. They are forgiving of tolerances, tool marks, and even slight misalignment.	Some anaerobic adhesives contain Teflon or similar lubricant fillers to aid in assembly. It is possible that these minute fillers can enter and contaminate hydraulic systems with micron-level filters. Maintenance technicians should consult with adhesive experts or sales representatives to determine which anaerobic adhesives are free of fillers.
Dryseal - Drysealing involves the use of threaded fittings made of soft or "yielding" metal. This tapered fitting seals by deforming the crests of the threads as the fitting is wrenched tight. The metal is forced into the roots of the opposite thread, sealing spiral leak paths at the crest and root of threads. If installed properly and not disassembled, drysealing can be very effective.	Galling may occur during assembly, creating a scratch-like leak path. If the joint is disassembled, the threads may cold-weld together and rip apart, making reassembly risky. In addition, overtightening may create cracks in the mating or housing at stress points.
O-Rings - The confined O-ring is a trapped elastomer used to seal joints that can be effective in sealing and preventing contamination.	O-rings are expensive and prone to sloppy assembly. If a ring is damaged or pinched during assembly, it will contribute to leakage.
Teflon tape - Teflon tape is not a sealant, but has been adopted for thread sealing because of the lubricity it offers.	Teflon tape is often banned in hydraulic and pneumatic systems because of its tendency to shred and contaminate sensitive areas. A single shred of the tape can cause excessive damage to a hydraulic system.
Pipe dopes/paints - These products flow into threads and cure to form a hardened seal.	Pipe dopes and paints contain solvent liquids that evaporate, leaving a shrunken seal that may crack and deposit large pieces in pipes, devastating hydraulic systems. Due to their solvent natures, these sealants are not resistant to many fluids. The other major ingredients in paints and dopes are fillers that can find their way into the systems they are sealing, blocking ports and unseating valves.
Latex-based sealants - Latex sealants are usually pre-applied by the fitting manufacturer. The material forms a yieldable interface for threads, plugs leak paths, and may be disassembled and reassembled 4 to 5 times.	Once worn, these seals are very difficult to replace. Latex sealants offer no locking ability and contain fillers that may contaminate hydraulic systems, particularly fine, micro-porous filters.